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Using Creativity to Develop Space Concepts

Editor's Note: This column was written with input from LTC Dennis Brozek

Artwork of future war machines painted in 1958 by LTC Robert B. Rigg gives a perspective of how possible military power today was seen then. This collection by the Army artist, decorates the U.S. Army Space and Missile Defense Command/Army Forces Strategic Command's Command Conference Room in Colorado Springs, Colo., as a reminder of the need for vision among military leaders. Each painting is the artist's rendering of a future weapon system – each one looks like something from a science fiction novel – some drawings look like parts of systems that are in the military inventory today. The point is: People can envision the future and imagine new and useful capabilities or concepts, and then work diligently to develop and test the ideas until they become realities in some form.

There's the tilt-wing plane – Vertol 76 – an Army/Navy joint research project that was to achieve flight in 1958 but never did. The U.S. Marines continued its development and today's Marine V22 Opsrey has logged well over 1,400 combat sorties in Anbar Province, Iraq, since October 2007. Another print is called "Flying Spy – Army Jet Drone." It is an unmanned, remote controlled plane that research and developers in 1958 were working on to conduct surveillance, reconnaissance and target spotting. Sound familiar? The painting and the concept look a lot like the U.S. Air Force's Predator Unmanned Aircraft System and, to some extent, the Army's XM157 Class IV Unmanned Aerial Vehicle of the Future Combat System family.

This provides an appropriate frame of reference for this edition of the Army Space Journal, which is dedicated to new Space concepts.

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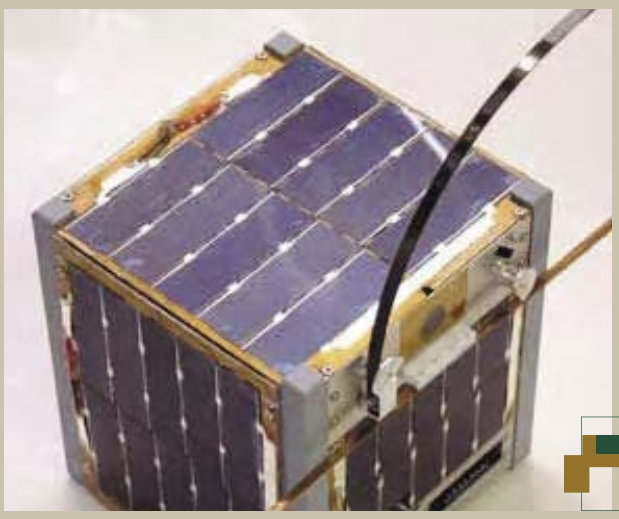

CubeSat, with dimensions of 10 x 10 x 10 cm, is a pico-satellite

The concepts discussed in this article have evolved either from a combatant commander's urgent need or surfaced from requirements identified by Soldiers on the ground. In an effort to fulfill these needs, scientists and combat developers have used their imaginations, intellect, and knowledge to come up with various solutions, many of which are still in the test and evaluation stage. LTC Dennis Brozek, USASMDC/ARSTRAT Future Warfare Center Experiments and Transformation Division Chief, provided several examples of concepts and hardware that survived the testing stage and are in use today.

Tactical Satellites

Although not a new concept, the reality of launching tactical satellites – an overarching term for satellites that can be built and launched within months and days rather than years that are in direct support of a joint force commander – is gaining momentum. For years, warfighters have seen the utility of the products and services that satellites provide them. Because of the demand for satellite bandwidth and the continuing threat to our current satellites, combatant commanders recognize the utility of adding small, agile satellites in order to "augment, surge and/or reconstitute existing assets."[1] However, up until now these "on-call" satellites were impractical because of the long lead time to launch and the overall costs of developing, building and launching them.

In 2007, the Department of Defense stood up the Operationally Responsive Space office at Kirtland Air Force Base, N.M., in order to rapidly "exploit and infuse Space technological or operational innovations; adapt or augment existing Space capabilities, and reconstitute or replenish critical Space capabilities …"[2] in response to joint force commanders' and others' immediate and urgent needs for Space capabilities. To complement improved responsiveness in existing capabilities, the ORS office is also developing more affordable, small satellites/launch vehicle combinations that can be launched in relevant timeframes. To meet this goal, the ORS engineers, under the direction of Dr. Peter Wegner, are exploring the potential use of the "plug and play" concept of the USB (Universal Serial Bus) for computers on tactical satellites. USBs have a standardized design that allows peripherals made by different manufacturers to be plugged into a personal computer.[3] ORS/Air Force Research Lab has published a catalog that tells civilian firms what protocols they need to follow in order to be compatible with others. So when a firm develops a product, that product can be plugged into/with/in conjunction to other products or systems developed by others. To be a part of the ORS program, competitors can no longer use company-proprietary data that makes it hard to produce compatible systems; instead, they must use open networks. As a result, ORS/AFRL is working and testing common payloads, a common bus, and common interfaces to create new satellites within days.

USASMDC/ARSTRAT's Battle Lab is the primary U.S. Army partner in the ORS office's Joint Military Utility Assessment for TacSat-3 and TacSat-4. The ORS office will use the lessons learned from the TacSat scientific experiments in their development of other responsive Space projects. Building on the results of TacSat 2's focus on electro-optical and radio frequency sensors to demonstrate enhanced Specific Emitter Identification and Automatic Identification systems and with tactical tasking and data dissemination, TacSat 3, when launched (tentatively in May 2009), will operate in two modes. The routine mode will collect imaging spectroscopy data to be processed and analyzed in traditional manner such as many of the national technical means currently available. This is nothing new. What is new is that the tactical mode will allow the theater commander to task the satellite where to look and for which spectral signatures. When the satellite "sees" that signature, the onboard processor will directly download the requested data into theater to the tactical warfighter. The fact that the warfighter is able to task the satellite, and receive its products within seconds to minutes is the groundbreaking innovation that is being demonstrated and evaluated for future warfighter application. TacSat 3 represents a new paradigm in Army-Air Force collaboration from the beginning or Research and Development throughout design,

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Here is an computer generated image of all the orbital debris in low earth orbit (LEO). LEO stands for low Earth orbit and is the region of Space within 2,000 km of the Earth's surface. It is the most concentrated area for orbital debris. (Courtesy of the NASA Orbital Debris Program Office)

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development, test and operations.

FYI: Max Delgado says UHF will support COTM. Planes use it. From satellites it doesn't work very well. UHF is definitely part of the experience.

Unlike the other three experiments, TacSat 4 – slated for launch in September 2009 – will focus on enhancing existing ultra high frequency-based communications with three mission sets: satellite communications-on-the-move, friendly force tracking and data exfiltraton from unattended U.S. Navy sensors. TacSat 4 is also a test bed for payload control via the new software tool called Virtual Mission Operations Center. This software is designed to allow the request for services, the approval process, and user feedback to be on a single Web-based tool that can be used by any authorized user with a Secret Internet Protocol Router connection. If successful, the communications-on-the-move package will allow the current generation of tactical radios such as the PRC-117, PRC-148 and PRC-152 to execute satellite communications on-the-move without using today's cumbersome satellite antennas that have to be set up at a halt. The goal is to allow for the use of whip and baton style antennas in order to make it as easy as talking on the cell phone in your car. During its experimental life, the satellite will offer an alternative method of data exfiltraton from unattended sea sensors and will provide higher levels of friendly force tracking than currently exists for U.S. Southern Command.

Both TacSat 3 and 4 experiments have a projected life of about two years. Both systems are experimental – not operational – systems. Because there is only one satellite in each experiment, each system will have limited, available orbital coverage. As with any experiment or test, the success or failure of each system tested will influence the development of future operational systems. Each system will go through extensive testing by each of the services and then seek approval to support high level (combatant command or joint) exercises as a sort of "graduation" event prior to them being launched and fielded to support any real world operations.

The take away point is that tactical satellites were someone's vision, developed from a need, and today these satellites are becoming a reality.

Space Debris

What will be the hot, new Space concept to either eliminate debris in Space or limit the damage it can do to orbiting items that military and civilians depend on? The problem is that countless pieces of trash are in Space – this trash can severely damage satellites and spacecraft. Some sources estimate that over 300,000 objects of at least 10mm in size are in orbit, and some 18,000 are over the 10cm size. It is estimated that the COSMOS 2251 crash into the Iridium 33 in January yielded 212 pieces of detectable debris.[4] The Chinese ASAT test in 2007 created about 2,500 debris particles. With over 900 satellites in orbit and a world dependent upon their services, we need to be concerned about things that can damage them. The reality of the danger was especially highlighted on March 12 when the astronauts on the International Space Station had to take shelter in the Soyuz capsule because a piece of Space debris was coming into close proximity. The problem will only get worse, according to Nicholas L. Johnson, NASA's chief scientist for orbital debris, in the NASA Orbital Debris Program Office. He says we need to figure out how to clean it up.[5]

> "With over 900 satellites in orbit and a world dependent upon their services, we need to be concerned about things that can damage them."

Bloggers on NETWORKWORLD have offered some humorous solutions: A big Space vacuum cleaner similar to the one in "Spaceballs" or a Space janitor like the one in Space Quest. How about a Space-roving WALL-E – that Disney-Pixar character from the 2008 movie of the same name? Some of the seriously considered suggestions include attaching balloons to pieces of debris to increase drag or attaching an electrodynamic tether to debris to create electricity so man can re-direct the used craft back to earth.[6] In 1990 SPECS, Inc. of the University of Texas at Austin studied the problem and designed a transfer vehicle with a net, and NASA has experimented with a gel in a honey-comb like mitt to catch and bring the debris back.

Many people are looking for a solution to this serious issue. The key here is that there may be leaders in our Army Space community with ideas that could work. If so, refer it to Nicholas L. Johnson, NASA's chief scientist for orbital debris, in the NASA Orbital Debris Program Office at http://orbitaldebris.jsc.nasa.gov/

Concepts put to the test

While NASA and others work on solutions to the Space debris problem, USASMDC/ARSTRAT is working on solutions that can be applied today though the Joint Capability Technology Demonstration. As the Army Service Component Command to U.S. Strategic Command, USASMDC/ARSTRAT is entrusted with the mission to rapidly deliver Space and high altitude capabilities. Through the Technology Center and Battle Lab, the command does this mission in support of the Joint, Interagency, Intergovernmental and Multi-National community's combat and Security, Stability, Transition and Reconstruction operations. The Joint Capability Technology Demonstration is one of the primary science and technology programs that USASMDC/ARSTRAT leverages.

The Department of Defense initiated the precursor to this program in 1995 – it was called the Advanced Technology Demonstration Program – with the purpose of demonstrating new, mature technologies in an operational environment. The goal was to obtain new technology and put it into the hands of users as quickly as possible. Using a streamlined development approach, the Joint Capability Technology Demonstration program brings together technologists and military – from all the Services – and civilian operators, who together insert advanced technologies into live demonstrations and exercises, evaluating their operational utility in the field, while tailoring operational concepts and tactics, techniques, and procedures for Joint, Interagency, Intergovernmental and Multi-National user employment. The program model specifically addresses congressional concerns and recommendations regarding rapid development and transitioning of commanders' relevant capabilities to the Joint, Interagency, Intergovernmental and Multi-National user in a more cost effective, timely and efficient model.

The Joint Capability Technology Demonstration and its precursor program have a long history of supporting rapid development of High Altitude capabilities. For example, in 1995, the U.S. Air Force began the High-Altitude Endurance Unmanned Aerial Vehicle program that we now know as Global Hawk. The High Altitude Airship was the next program to explore how the Department of Defense could further provide wide area, long endurance coverage for the Joint, Interagency, Intergovernmental and Multi-National community. While the

Revolution in Future Flight: The Tilt-Wing Plane

The first tilt-wing plane. the Vertol 76, is turbine powered. Funded by the Army and developed in cooperation with U.S. Naval Research, it is expected to achieve flight conversion in 1958.

Atomic Era City Defender: Nike Hercules

There was no further information provided by the artist.

Flying Spy: Future Army Jet Drone

A concept of unmanned, remote-controlled drone – a 1958 Research and Development project to provide drones to accomplish: battlefield surveillance, target spotting, nuclear fallout monitoring, radiation detection, countermeasures control and tactical reconnaissance.

Night Reconnaissance

Air Cavalry's flying jeeps of the future will shoot to obtain information. A ducted-fan aerial jeep of this undergoing Army development

Army Air Cavalry Vehicle of the Future

An aerial assault vehicle and aerial jeep — 1958 Research and Development projects designed to provide the pentomic Army with 3-dimensional means of target acquisition, reconnaissance and attack.

Breaking Traditional Terrain Barriers

Army R&D is in quest of a flying crane, which can carry payloads of up to 12 tons for distances of 50 miles, and lift small armored vehicles over rivers and other terrain barriers. One 1958 concept is the Hiller duct-fan type crane.

U.S. Army SGT Ryan Pike from 2nd Battalion, 8th Infantry Regiment, 2nd Brigade Combat Team, 4th Infantry Division and SSG Altaf Swati set up a tactical satellite radio during a patrol to check the progress of several school construction projects, funded by the Iraqi government, in Afak, Iraq. Department of Defense photo by Senior Airman Eric Harris, U.S. Air Force.

full scale High Altitude Airship prototype ran into program and engineering challenges, USASMDC/ARSTRAT – along with the Missile Defense Agency – have continued to push the capability forward and will fly a sub-scale prototype of the original High Altitude Airship design in 2009.

In 2007, USASMDC/ARSTRAT became a partner on two Joint Capability Technology Demonstrations: Global Observer high altitude platform and the Zephyr. The Global Observer will demonstrate a long-endurance, liquid hydrogen-powered, unmanned aerial vehicle in 2009 and 2010, which can stay on station a week and provide both intelligence, surveillance, reconnaissance and communications support. The Zephyr is a solar-powered, fixed- wing, unmanned aerial vehicle designed to meet urgent operational requirements for U.S. Central Command and U.S. European Command. This program, if successful, could provide low-cost persistent surveillance and communications relay, flying continuous operations for months at a time using solar power and batteries for continual flight. The Zephyr has already had successful test flights and is the current record holder for High Altitude endurance flight. Its mission set will provide communications relay and electro optical capability to the Joint, Interagency, Intergovernmental and Multi-National community should the operational utility prove worthy.

Space systems have also enjoyed the benefits of the Joint Capability Technology Demonstration rapid capability development program. In 2000, the Global Monitoring of Space Intelligence, Surveillance and Reconnaissance Systems program demonstrated the operational value of providing near-real-time information on potential threats to theater operations posed by commercial Space systems. This capability allows the theater commander to take mitigation actions to avoid the threat of detection from commercial spacecraft. This capability is in use today with joint Space forces around the globe.

In 2006, USASMDC/ARSTRAT began another Space related Joint Capability Technology Demonstration program called Extended Space Sensors Architecture. The program addresses gaps in Space situational awareness and integrates technology from different mission areas (missile defense and Space superiority) to give commanders the situational awareness they need to act within their time requirements. USASMDC/ARSTRAT's Technology Center is playing a major role in technology development and the Battle Lab is acting to integrate and demonstrate this new capability in operations.

The Battle Lab's most recent Space capability programs are the Internet Router in Space and Communication AirBorne Layer Expansion Joint Capability Technology Demonstration. The Internet Router in Space program will leverage a wholly-owned and operated commercial payload onboard IntelSat's IS14 satellite scheduled for geo-stationary orbit in late 2009. The program has the potential to be a transformational technology capability as it seeks to provide routed cross-band, (Ku-C) and cross beam transceived Internet Protocol communications to the European, African and South American regions. Internet Router in Space capability could provide secure, reliable access to the network with a common toolset of infrastructure services, information assurance and interoperability. If the program proves to have operational utility, its transition will provide a Defense Information Systems Agency contract mechanism to enable the Joint, Interagency, Intergovernmental and Multi-National community use of the Internet Router in Space capability on a fee for service basis. Communication AirBorne Layer Expansion is aimed at enhancing air, land and maritime domain communications systems, and will provide a next generation airborne network extension capability to the tactical edge.

The Joint Capability Technology Demonstration program has been an invaluable tool in rapidly developing hot, new Space and high altitude platform concepts. This program will continue to be instrumental in providing a vehicle to integrate and demonstrate new capabilities in both combat and Security, Stability, Transition and Reconstruction operations.

ROUND"

Tactical Satellite-3
Integration of the modular bus components on Tactical Satellite-3 is photographed at the Air Force Research Laboratory's Space Vehicles Directorate, located at Kirtland Air Force Base, N.M. (Air Force photo)

Conclusion

Today's scientists, combat developers and others are tackling tough Space-related issues like dealing with Space debris that could damage our satellites, building responsive Space vehicles and developing high altitude platforms with hot, new concepts. To do this, the community is using the Joint Capability Technology Demonstration process, NASA's experimental process, or the civilian industry's research and development resources.

The primary question military operators and Space professionals ask about the process and final products is: "Will this new concept serve the warfighter well?" While performing their duties as Space operations officers and Space enablers, this entire community will continue to ask the same question. They will be assessing all aspects of military operations to determine what other urgent needs can be satisfied by the Space-based systems being developed. The goal is to push the needs statement forward. Space professionals with operational experience should be involved in the development, test and evaluation of new concepts. Who knows, they may become the ones configuring or reconfiguring the payload on a High Altitude Airship or a small satellite in the future. It is not beyond the reach of any of those Space professional/Space enablers to have a viable solution to the issues that face the Space community.

These solutions begin with an intellectual dissection of the problem and an educated imagination asking "what-if" or "I think we could use this to do. . . . " The resulting Space machine or Space concept could become the subject for an Army artist's canvas in tomorrow's military context.

Footnotes

[1] "Plan for Operationally Responsive Space, A Report to Congressional Defense Committees," Department of Defense, Washington, D.C., Apr. 17, 2007.
[2] Ibid
[3] Holmes, Erik (Feb. 20, 2009) Lab To Build Special Order Satellites in Days. Air Force Times
[4] Brown, Peter J. (February 2009) Things That Go Bump In Space, Part 1. The Asia Times, GET PAGES
[5] Experts Seek Solution to Space Debris Orbiting Earth. (Feb. 20, 2009) RedOrbit.
[6] Experts Seek Solution to Space Debris Orbiting Earth. (Feb. 20, 2009) RedOrbit.

"SECURE THE HIGH G